ARTICLES 401 (EROSION CONTROL PLAN) & 405 (REHABILITATION AND RESTORATION PLAN)

PROJECT NO. 2035-006

Purpose

This *Erosion Control and Rehabilitation and Restoration Plan* meets the requirement of Articles 401 and 405 of the license and has been developed in concert with the U.S. Forest Service's 4(e) Conditions, which include Conditions 104 (*Fish and Wildlife Mitigation Plan)*, 106 (Article 416 - *Recreation Management Plan*) and 107 (Article 406 - *Weed Management Plan*). Due to the interrelated aspects of the *Erosion Control Plan* and the *Rehabilitation and Restoration Plan*, these documents have been combined to provide a more complete picture of the existing conditions and the recommendations developed to mitigate impacts of past, present and future recreation.

FERC Requirements

EROSION CONTROL AND REHABILITATION AND RESTORATION PLAN

The following eight items address the specific requirements of FERC Articles 401 and 405. (*This section is followed by a detailed description of existing site conditions and other factors that might influence erosion control and restoration along with site-specific conditions and recommendations*.)

1. Goals

The goals of the *Erosion Control and Rehabilitation and Restoration Plan* as developed by Denver Water and the Gross Reservoir RMP Project Team are as follows:

Erosion Control and Restoration Goals

- Mitigate the impacts associated with the development of new recreation facilities
- Where practical restore natural drainage patterns and erosion control impacted by recreation.
- Detain and divert surface runoff along permanent trails to prevent erosion
- Divert foot traffic away from eroded social trails
- Initiate recovery of natural vegetation capable of erosion control

Rehabilitation and Restoration Goals

- Revegetate with native species
- Establish protection of revegetated areas
- Use on-site materials
- Provide visual amelioration of disturbed and rehabilitated areas

2. Rehabilitation and Restoration Techniques

After a thorough evaluation of existing site conditions the following rehabilitation and restoration techniques will be implemented. These general categories are addressed again in the Site Specific Recommendations Section below.

Categories of Revegetation / Restoration Need

2.1 Social Trails without Major Soil Loss (see photos 1 & 2 page 3)

In these areas, the major effort will be to loosen compacted soils, rake materials from adjacent areas and/or seed with the appropriate mix, stabilize during establishment and protect from further use as trails. These areas generally will have to be treated with manual labor. In some cases, small, probably tracked machines could be employed to rip / chisel the surface prior to seeding, but most areas will require hand treatment with picks, McLeods, or Pulaskis. Seeding of the mix in Table 1 will be done at the rate indicated and then the area will be raked with metal-tined rakes. The area will be mulched with certified weed-free straw and jute netting will be applied over the straw, then anchored with rocks, logs, and/or biodegradable staples. For all social trail restoration, obstacles, especially dead and unlimbed or partially limbed trees will be placed across the rehabilitated area to strongly discourage trail users from entering. Such efforts will be most intensive in the areas of heaviest trail use and in areas where it will be difficult to deflect attention from a potential "shortcut."

2.2 Social Trails with Complete Soil Loss down to Weathered Granite (see photos 1 & 2 page 4)

In areas in which soils have been eroded down to weathered granite parent material, the surface will be loosened as in 2.1, then BioSol will be added at the rate of 40 lb/1000 sq. ft., and worked into the soil with rakes. Seeding and mulching will proceed as in 2.1. In addition to seeding and mulching, nursery stock will be placed in locations chosen to block / divert pedestrian use and provide visual amelioration of social trail damage (see Table 1).

2.3 Social Trails with Complete Soil Loss down to Cobbles and Boulders (see photos 1 & 2 page 5 and photos 1 & 2 page 6)

In areas where the loss of soil has left a predominant cover of resistant cobbles and boulders exposed in a well-defined depression, reestablishment of natural drainage patterns may necessitate the import of fill materials. For these areas, a decision as to the extent of rehabilitation will need to be made. At one level, the choice could be

made to establish vegetation in the soil / non-rock substrate that remains and construct water diversion structures to keep the area from deteriorating further. Use of shrubs and trees to discourage foot traffic and at least partially ameliorate visual contrast would also be necessary at a minimum. For areas that are sufficiently narrow, soil materials could be pulled in from the sides to provide at least some plant growth medium.

At a slightly higher level of expense, enough suitable fill (not topsoil, but rather suitable growth medium from a local weed-free borrow area) could be added to provide native grasses, wildflowers and other plants sufficient environment to establish a vegetational cover approximating that of the adjacent natural areas. At yet a higher level, sufficient fill would be added to eliminate the trail depression and reestablish natural contours along with natural vegetation. In the deepest such trail depressions (greater than 6 inches; *see, for example photo 1 page 8*), some volume can be restored through use of rock fill overlain with weathered granite subsoil from local sources (site(s) to be determined).

Tree /Shrub Establishment in Visual Amelioration Areas

In the visual amelioration areas west of the dam, trees will be planted as follows:

Ponderosa Pine (Pinus ponderosa)……..40 / ac
Douglas-fir (Pseudotsuga menziesii)……40 /ac
Limber Pine (Pinus flexilis)……..10 /ac

Trees will be planted as 18-inch stock in May or June. Woven landscape fabric (one square yard) will be provided to each and the corners will be anchored with rock or biodegradable staples. Wood chip mulch will be placed over the fabric to a depth of two inches. Trees will be watered in with one gallon at the time of planting and watered throughout the first growing season with one gallon applied every three weeks from planting to Sept. 15. Welded wire cages 15 inches in diameter and 36 inches tall will be installed on each and anchored with two four-foot lengths of rebar driven at least 12 inches into the ground.

In addition to the planting of trees, an overseeding with the mix listed in Table 1 will soften visual contrast.

Modification of the Aggregate Storage Area Prior to Tree Planting

The ground surface in the aggregate storage site to the northwest of the dam is dominated by a thick layer of well-sorted uniformly coarse rock product that was presumably left over from concrete formulation during the construction of the dam. The absence of fine-earth particles renders it virtually useless as a plant growth medium as evidenced by the absence of volunteer plants of any sort *(see photo 2, page 8 and photos 1 & 2 page 9).* In order to relieve the strong visual contrast of this area in the overall scene around the dam, it is necessary to provide some alternative

plant growth medium. It is recommended that the approximately 2.8 acre aggregate area be covered with rock and subsoil to a depth of three feet. This would be followed by placement of 150 tons of large rock as naturally as possible. This approach will create an environment that will support tree growth and limited herbaceous layer growth. Trees will be planted at the rate of 90 per acre as detailed above. The volume of material to be moved in this plan will be substantially less than attempting to remove the aggregate stockpile itself. To provide the most efficient implementation of this plan, a local source of suitable fill should be located by Denver Water.

Approaches to Protection of Rehabilitated Areas

Critical to the success of rehabilitation efforts will be the deflection of pedestrian use away from those rehabilitated areas, confining them to the designated trails. Toward that end, the use of crusher fine trail coverings, at least in the high traffic areas (within one quarter mile of the Haul Road facilities along the South Boulder Creek Inlet Trail and all parts of the North Shore Area), will not only enhance trail usability but also will define the appropriate trail in the minds of more users. Rehabilitated areas adjacent to designated trails will have large rock and brush included to discourage trespass by constituting direct obstruction and visual screening. Signing to the effect that foot traffic is prohibited because restoration is in progress will be placed in the high traffic areas. Such signing should also be placed in locations where the temptation to traverse rehabilitated areas is, by virtue of geometry and line of sight, particularly great.

General Erosion Control and Restoration Plan

The following recommendations address the needs for erosion control along trails to be used permanently under the *Recreation Management Plan* as well as areas where the remediation of informal (social) trails and trail networks is undertaken.

Permanent Trails

Erosion control on permanent trails has, at the design level, been accomplished in the routing of new trails by minimizing trail slope. Most trail reaches are 10 percent or less in slope (i.e., <10 (h): 1(v)). During construction / reconstruction, inclusion of water bars on both existing and new sections will be accomplished to divert runoff before it accumulates to a damaging magnitude as it has on many of the existing unplanned social trails. Water bars will be installed at the following intervals in relation to trail grade:

Percent Slope	*Water Bar Spacing (ft)*
<2 %	none required
2 to 5 %	150
5 to 10 %	100
10 to 20 %	50

20 to 33 %	30
33 to 40 %	25
40 to 50 %	20
> 50 %	10

Additional water bars will be installed at locations that in the judgment of the overseeing engineer or design technician should have them.

Water bars will be oriented to allow intercepted runoff to be directed off the trail without accumulating standing water behind them. Water bar locations will be adjusted as necessary to avoid disturbance of important local botanic or other natural features. Water bars will be constructed between 8 inches and 10 inches in height (as measured from the bottom of the trough).

Rehabilitated Social Trails

Erosion control used in rehabilitation areas will depend on the level of restoration chosen. Options most closely resembling restoration of the natural slopes and vegetation will enjoy the omnipresent erosion control of a natural vegetation cover. Areas only partially rehabilitated will depend to a larger extent on the presence of structures like water bars to deflect flows and prevent further deterioration. See the Site Specific Recommendations section below for more specific information on the revegetation of trails.

Where the rehabilitation process seeks to restore vegetation cover, the ground surface, manipulated to a condition so as to function as a good seedbed, will be covered with straw and erosion control fabric (see below) that will serve an important role in erosion control for the first few years after treatment.

3. Seed Mixes and Planting

The following seed mixes and nursery stock plantings (Tables 1 and 2) will be utilized for revegetation and restoration at Gross Reservoir.

Table 1. Seed Mix for Revegetation of Social Trails and Other Disturbances in the Gross Reservoir Area

Species	Common Name	Variety Rate	(PLS lb/ac)	%*
Festuca saximontana	Rocky Mtn Fescue – Native	0.7		20
Bouteloua gracilis	Blue Grama – (Bad River)	1.1		20
Sitanion hystrix	Bottlebrush Squirreltail – Native	4.5		20
Agropyron trachycaulum	Slender Wheatgrass – San Luis	2.7		10

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Ceratochloa marginata	Mountain Brome – Bromar	3.9	08
Muhlenbergia montana	Mountain Muhly – Native	0.05	02
Leucopoa kingii	King Fescue - Native	0.4	06
Artemisia frigida	Fringed Sagewort	0.02	02
Achillea lanulosa	Western Yarrow	0.03	02

* Percent of seed mix by seed number

Table 2. Species to be Planted as Nursery Stock (Verify with Arapaho-Roosevelt National Forest seed zone maps)

Shrubs *Scientific Name* (Common Name)	**Trees**
Salix scouleriana (Scouler Willow) *Acer glabrum* (Rocky Mountain Maple) *Padus virginiana* (Chokecherry) *Oreobatus deliciosa* (Boulder Raspberry) *Ribes cereum* (Squaw Currant) *Arctostaphylos uva-ursi* (Kinnikinik)	*Pinus ponderosa* (Ponderosa Pine) *Pinus flexilis* (Limber Pine) *Pseudotsuga mensziesii* (Douglas-fir)

4. Fertilization and Irrigation Requirements

In general, native plant species do not respond to fertilizer like other plants do, most notably invasive weeds. Therefore, fertilizer will not be applied to the restored areas unless the borrow material proves to be nitrogen deficient. In this case, a slow release nitrogen amendment will be added.

Unless extreme drought conditions persist after seeding, none of the seeded areas will require watering. All of the woody plantings will be watered in late spring at the time of planting and for every two to three weeks during the first growing season. The use of landscape fabric and mulch should promote the efficient use of water.

5. Rehabilitation Monitoring Program

As described in the *Recreation Monitoring Plan* the following Resource Survey will be utilized to monitor rehabilitation and restoration efforts.

Resource Surveys

Purpose
The purpose of the resource survey is to monitor the success and failures of the rehabilitation and restoration efforts. In addition, this survey should locate areas where new resource damage is occurring.

Methodology
Conduct an annual field survey to monitor actual facility and resource changes. A specialist familiar with the existing site conditions and the restoration techniques should conduct a mid-summer survey. The data collection should include a photo-point survey. This photographic inventory should document the conditions of the following site features:

- Existing structures including buildings, signage and fences
- Recreation amenities including picnic tables, grills, fire-rings and trails
- Restored landscape areas impacted by recreation
- Areas where new resource damage is occurring from recreation

Once the permanent photo locations are established, subsequent photos should be taken each year to document changes.

In addition to the field survey, several ongoing monitoring systems should be in place including:

- Maintenance schedules – describing facility maintenance, trial maintenance, etc.

Outcome
Denver Water will compile a database in one central location that is in a format that is easily accessed by surrounding entities (USFS, BCPOS, BCSO, Cherryvale FPD and other interested parties). This information would enable Denver Water to intervene before severe facility or resource damage occurs. The photo inspection would also reveal less noticeable changes including erosion and the widening of trails.

6. Monitoring Report Filing Procedure

The facility and resource condition data collected through this monitoring program will be maintained in one area at Denver Water. The monitoring results will be evaluated each year by the Interagency Committee.

7. Procedure for Modifying Unsuccessful Restoration

Upon evaluation of each year's monitoring results, needed changes will be identified and implemented in a prioritized manner. The variety of restoration and erosion control techniques being implemented should provide some basis for modifying practices that prove unsuccessful. In the event that adopted practices are unsuccessful, alternative methods will be explored and implemented.

8. Implementation Schedule

The existing erosion control and restoration issues and techniques have been identified and documented for each of the 10 recreation sites *(see Site Specific Existing Conditions)*. In addition, specific techniques have been developed to address erosion control and restoration. Upon approval of the plan from the Commission, the erosion control and rehabilitation and restoration practices will be implemented in conjunction with site improvements on a site-by-site basis.

BACKGROUND & SITE SPECIFIC CONDITIONS AND RECOMMENDATIONS

EROSION CONTROL AND REHABILITATION AND RESTORATION PLAN

Methodology

The *Erosion Control and Rehabilitation and Restoration Plan* was developed by the project consulting team under the direction of Denver Water. The project consulting team included specialists in the areas of planning, landscape architecture, resource management, law enforcement and safety, marketing and research, ecology and restoration, and economic development. Throughout the development of this plan, the project consultants contacted Denver Water staff and other key agencies affected by Gross Reservoir recreation management issues including the USFS, Boulder County Parks and Open Space, Boulder County Sheriff's Office, City of Boulder Open Space and Mountain Parks, Colorado State Parks, Coal Creek FPD, Cherryvale FPD, High Country FPD, Bureau of Land Management, Preserve Unique Magnolia Association (PUMA), U.S. Fish and Wildlife Service and the Colorado Division of Wildlife to discuss issues and opportunities at Gross Reservoir.

Existing Conditions

The information presented in the existing conditions report was gathered through field analysis, meetings with Denver Water, the US Forest Service and various stakeholder agencies. Information was also taken from the following reports: FERC No. 2035-006 *Final Environmental Assessment For Hydropower License,* Volumes I, II, III and IV of the FERC No. 2035 *Gross Reservoir Hydroelectric Project* and the *Magnolia Environmental Preservation Plan*.

Overall Natural & Visual Features

This section addresses the overall natural and visual features found at Gross Reservoir. Site-specific analysis for each recreation area follows.

Weather/Climate

The weather at Gross Reservoir is volatile. The reservoir's location at 7,250 feet of elevation near the Continental Divide leaves it exposed to rapid weather changes throughout the year. In the summer, its proximity to the Indian Peaks to the west, affords little warning of approaching convection-driven thunderstorms. In the fall, winter and early spring, it is subject to very strong gusty downslope winds as air masses from the west push over the Continental Divide and descend, warming and gathering speed (Chinook winds).

Summertime monsoons often bring short mid-afternoon thunder or hailstorms accompanied with high winds. It's not uncommon to have northwest winds reaching 80 mph during the summer. Chinook winds strike between November and March, with gusts exceeding 100 mph. In general, the northern and western aspects adjacent to the reservoir are prone to higher winds.

Summer temperatures are generally mild - days above 95 degrees are rare, humidity is low. Winter temperatures are usually quite cold. The skies are clear about 115 days out of the year and partly cloudy another 130 days. Annual precipitation averages between 20 and 25 inches. Over half of the precipitation falls during the months of April and May. January and February are the driest months. Warm, sunny winter days generally melt snow quickly, although snow can linger in some areas throughout the winter.

Water

Gross Reservoir is a drinking water storage facility for the city of Denver. The reservoir's primary source of water is South Boulder Creek that includes water diverted from the west slope. Flows within this watershed are supplemented with water diverted beneath the Continental Divide. Water is diverted from the west slope of the Front Range through the pilot bore of the Moffat Tunnel and into Gross Reservoir. Roughly 60,000 acre-feet of water from the Fraser River flows through the tunnel, then down South Boulder Creek and into the reservoir each year. The South Boulder Creek watershed accounts for 45 percent of the flow into Gross Reservoir (MEPP 2000). In addition to these water sources, several smaller drainages flow into Gross Reservoir including Winiger Creek and Forsythe Creek. Most of the runoff in these drainages is derived from seasonal snowmelt.

When full to the spillway crest, Gross Reservoir stores 40,990 acre-feet of water. The surface area of the reservoir covers 418 acres, creating 10.9 miles of shoreline. The water reaches a depth of 280 feet near the dam.

The depth of the reservoir results in cool water temperatures throughout the year. Summer water temperatures only reach 18 degrees Celsius (64 F) on the surface. Temperatures cool 2 degrees C (3.6 F) per foot below the surface, down to 6 feet. Below 6 feet, water temperatures are generally in the 6 (42 F) to 8 (46 F) degree C range. According to the U.S. Coast Guard, survival times for victims in water of this temperatures range from 1 to 3 hours depending upon environmental factors and the person's physical condition.

Gross Reservoir usually freezes over by January. During the mid to late winter months ice fishing occurs at several locations on the reservoir. This activity has its risks due to the unpredictability of ice conditions.

The water levels at Gross Reservoir fluctuate greatly depending upon the time of year and user demand. Rarely does the reservoir maintain a consistent level for any length of time. Water levels can fluctuate as much as 100 feet throughout the year. Typically a low water elevation of 7,180 feet occurs in early May prior to spring run-off. By mid June the reservoir usually reaches its capacity at 7,280 feet. Due to high water demands, Denver Water attempts to keep the reservoir fairly full through June, July and August. However, by July or August customer demands are usually greater than the water supply, so the water level begins to drop. During the winter there is very little fluctuation in water level.

Water supply operations will not be changed to accommodate power generation. The turbine and the generator will likely be operated from April through September as dictated by the releases to meet municipal water supply needs.

Physiography

Gross Reservoir lies in the foothills of the Colorado Front Range, in an area formed by the uplift and erosion of Precambrian granite bedrock. Since the end of glaciation, the landscape has been sculpted by deep erosion, the deposition of stream deposits and the downward migration of unconsolidated rock *(see photo 1 page 18)*.

Elevations within the FERC boundary range from 6,800 feet below the dam on South Boulder Creek to 8,100 feet atop some of the small peaks on Winiger Ridge. In most cases the terrain slopes steeply in the direction of the reservoir. As a result, the majority of land along the south side of the reservoir has a northerly aspect and land along the north side has a southerly aspect.

With the exception of Winiger Ridge, most of the slopes surrounding Gross Reservoir are very steep. The majority of slopes exceed 25% along the reservoir's edge. This predominance of steep slopes makes access to and from the reservoir very difficult.

Located throughout the site along the reservoir's steep side slopes are numerous large granite outcrops. These formations are very prominent due to their lack of vegetation and the sheer size of the cliff walls.

Soils of upper slopes and ridges have often formed in residual material that has accumulated in-place from the disintegration of weathered granite bedrock material. Soils on side slopes and toeslopes have often formed in colluvium, unconsolidated rock material which has moved down slope under the influence of gravity.

Erosion

Most soils found around Gross Reservoir have high erosion hazard. This hazard is primarily due to steepness of slopes. While soils appear relatively stable at present, removal of their protective cover of vegetation can leave them very susceptible to erosion. In general, erosion along and above the reservoir shoreline can be described as slight with a few areas of moderate to severe erosion where human activity has long ago removed the protective vegetation cover along social trails. Where unimproved automobile access roads reach the shoreline, erosional damage is often serious *(see photo 2 page 18).* From these trail and road areas, erosion has moved thousands of tons of material into the reservoir. The bulk of sediment reaching the reservoir originates outside the immediate area affected by trails and road and is delivered by South Boulder Creek and other natural drainages.

Erosional damage in the study area has extended from the surface downward into the subsoil in many places, and in some places has removed all subsoil to expose solid granitic bedrock. The bulk of the latter severe damage is located along the North Shore area where dispersed heavy foot traffic has allowed the most extensive destabilization. After the top soil layer (generally 4 to 8 inches) is removed, the subsoil, mostly 10 to 20 inches thick, offers little resistance to erosion because most is gravelly loamy sand which means that it has few fine particles to cement the larger particles together.

Vegetation

The vegetation at Gross Reservoir is typical of the Lower Montane life zone *(see photo 1 page 21).* In this life zone, ponderosa pine and Douglas-fir comprise the dominant species in usually open woodland conditions. On warm south-facing slopes ponderosa pine predominates while Douglas-fir forest predominates on the cooler north facing slopes. Aspen groves are common in wetter areas where past disturbance or fire has occurred. Other plant community types found near the reservoir include small wetland or riparian areas and mountain grassland.

The conifer forests found near the reservoir range from thick stands of young trees occurring primarily on north-facing slopes to more open canopies of large trees on south and west facing slopes. In most areas, the forest is encroaching into the few remaining meadows. Forest stands include individuals of widely varying age, but are

skewed toward the relatively young categories. The high density of trees has resulted in much competition between trees and frequent stressed health is apparent. Aspen forests are found in wetter areas along ravines and drainages. These too are slowly being replaced by conifer forest. Due to earlier forestation, few if any old growth forests remain.

The suppression of natural fire cycles has resulted in a build-up of fuels in the forest. This fire hazard was demonstrated in September 2000 when the Walker Ranch Fire burned over 1,100 acres of Boulder County Open Space land on the eastern edge of the site. This fire was believed to have been caused by an unattended campfire. The fire burned for several days under hot and dry conditions. In addition to the fire hazard, suppression has also resulted in moderate to severe insect infestations.

The wetlands found within the FERC study area are located primarily along South Boulder Creek, Winiger Ridge and Forsythe Canyon. These wetlands tend to be very narrow, but offer habitats conducive to supporting a variety of plant and animal communities not found in the forested uplands. Some of the plants that can be found in these areas include: narrowleaf cottonwood, thinleaf alder, western river birch, Bebb willow, mountain willow, twinberry, chokecherry, and red-osier dogwood.

Several species of noxious weeds are found near the reservoir. Most common are cheatgrass (downy brome) and alyssum. Less common weeds found in isolated populations include diffuse knapweed, musk thistle and Canada thistle. Overall, at present weed infestations are not a serious problem, meaning that management to prevent serious infestations has strong potential to be effective. Lists of plant species observed during 2001 vegetation surveys of Gross Reservoir area are available in Brune (2001).

Site Specific Existing Conditions

This section addresses existing erosion and resource damage found at each of the ten recreation sites *(see Map 1)*

North Shore Recreation Area *(see Existing Site Character, Map 2)*

The North Shore's close proximity to the water and the number of users has resulted in the development of a myriad of social trails *(see photo 2 page 21)*. Foot traffic has destroyed vegetation cover and initiated erosion of topsoil. Overland flow accumulated in the trails along upper slopes has in some places extended damage from areas directly trampled into areas downslope. In some areas the damage and ensuing erosion has been so severe that the underlying bedrock has been exposed. Although exposed bedrock areas are at a stable configuration themselves, they contribute nearly 100 percent runoff during rain events, exacerbating erosion problems downslope.

All three of the North Shore picnic areas are connected with a social trail that runs along the top of the ridge. For the most part, the trail is in good shape and is easy to follow.

Unfortunately, the same cannot be said for the social trails that drop south off the ridge and down the steep slopes towards the reservoir. Over the years the deep drainages that run from the ridge-top down to the reservoir have been overrun with social trails. These trails have resulted in severe erosion and environmental degradation. Some of these drainages have been scoured of all soils and vegetation, exposing bedrock *(see photo 1 page 23)*. Estimates put the damaged resource areas at several acres.

Peninsula Recreation Area *(see Existing Site Character, Map 2)*

Although foot traffic has been intense along the trails, the general prevalence of low slope on the Peninsula has minimized the extent of erosional damage. Some erosion has occurred on the end of the peninsula just below the highpoint.

Dam Recreation Area *(see Existing Site Character, Map 3)*

The overall bare nature of this site is primarily a vestige of its status as a construction staging area for the dam. Because of its size, this dam area is the single most prominent bare area on the Gross Reservoir property. Although most of the barren nature is a direst result of construction disturbance, the lack of vegetation cover has left little to stop erosional losses. In other areas, only small grasses have managed to establish.

South Boulder Creek Outlet

The access trail to South Boulder Creek below the gauging station has seen moderate erosion along some of the steeper sections. Additional foot-traffic could result in a substantial increase in erosion and resource degradation.

Haul Road Recreation Area *(see Existing Site Character, Maps 4)*

The Haul Road is situated within a deeply inset cut which traverses a steep north-facing slope. The road itself occupies a very narrow cut and fill bench *(see photo 2 page 23)*. The bench has highly eroded slopes both above and below it. At many locations, the backslope (cut slope) is bedrock that was exposed during construction. The steep fill outslope along the road has apparently never been systematically treated to reestablish erosion control and is locally heavily eroded as a result of unimpeded run-off from above. Social trails created by recreational users have limited the volunteer establishment of vegetation to scattered native shrubs.

South Boulder Creek Inlet *(see Existing Site Character, Map 5)*

This area is alleged to have the best fishing on Gross Reservoir. As a result, several social trails connecting the Inlet to the Haul Road have developed over the years. The social trail that accesses the inlet originates at the end of the Haul Road. The roughly two-mile trail travels west over a series of ridges and down through several deep drainages where the elevation of the trail meets the reservoir high-water line. Some of the worst-eroded areas of trail are found near these drainage crossings where trail orientation straight downslope seems to reflect hikers' desire to reach the reservoir as quickly as possible and/or avoid a lengthy contour traverse to the upper reaches of the intervening drainage *(see photo 1 page 25)*. In some of these slopes next to drainages, collateral damage from water flow directly along the fall line has created very deep erosional channels.

Similarly, as the access trail from the Haul Road parking area nears the actual South Boulder Inlet area from a location several hundred feet above the reservoir and creek, no clearly advantageous route presents itself to the hiker. Consequently, over the years a number of social trails nearly straight downslope have developed as hikers have "bush-whacked" to the creek and reservoir. Erosion along these trails in this last reach is locally severe but has often been checked by the extremely rocky nature of the substrate.

Winiger Gulch Inlet *(see Existing Site Character, Map 6)*

Erosion and resource damage in this area is primarily the result of four-wheel drive vehicles. The closure gate on Winiger Gulch Road bars access out of this area, forcing drivers to return to Winiger Ridge by driving up the steep roads. The U.S. Forest Service has proposed to create a Travel Management Plan to analyze the roads and visitor use in this area. This plan will be initiated when funding allows and will determine which of these social roads to close.

Winiger Ridge Access and Recreation Area *(see Existing Site Character, Maps 7 & 8)*

This area is a popular destination for four-wheel drive enthusiasts. Numerous temporary logging roads and recently developed (unauthorized) four-wheel drive roads can be found throughout the area *(see photo 2 page 25)*. This use has resulted in severe resource damage in some areas. Motorists driving off designated roads have caused significant erosion on some of the steeper hillsides and within seasonal drainages. The U.S. Forest Service is preparing a Travel Management Plan to study the roads and visitor use in this area.

Similar to the evolution of social foot trails, these vehicle tracks often follow routes dictated by convenience *(see photo 1 page 29)*. Relatively few passes by heavy lugged tires on these machines result in effective elimination of vegetation. Where these tire tracks are off-contour, the onset of erosion is rapid. Inasmuch as these

erosional scars occur in parallel sets, the visual contrast is strengthened. From long distant views across the reservoir, these erosion scars are conspicuous in some cases.

The dirt parking area at the intersection of 359 and 68J has also experienced extensive erosion. This area sits in the bottom of a large drainage. As a result, significant erosion problems occur within the parking lot. The center of the parking lot has become channeled and scoured of soil.

Jumbo Mountain *(see Existing Site Character, Map 9)*

The cut-slope along the north side of the railroad bed has resulted in a highly visible scar that dominates the hillside. In addition, extensive erosion along the three to five foot banks separating the picnic sites from the creek is also apparent. Currently there are no defined access points to the creek from the picnic area.

The sites located directly adjacent to the river's banks have experienced extensive erosion. Some of these facilities are in jeopardy of being lost if the erosion problems are not mitigated.

Rocky Point Area *(see Existing Site Character, Map 10)*

Social trails between the parking area atop the ridge and Jumping Rock have resulted in extensive erosion and resource damage. Most of this damage occurs along the drainages. Foot traffic has destroyed the vegetative cover and has initiated erosion of topsoil. In some areas the damage and ensuing erosion has cut deep gullies, exposing bedrock. Although exposed bedrock areas are at a stable configuration themselves, they contribute nearly 100 percent runoff during rain events, exacerbating erosion problems downslope.

In addition to social trails, environmental resource damage has been severe in other areas. Fences have been removed by visitors in sensitive resource areas to accommodate additional parking.

Site Specific Recommendations

This section addresses the site-specific facility, erosion and restoration improvements proposed at Gross Reservoir.

Remediation of erosion problems in the Gross Reservoir study area is inextricably related to the Rehabilitation / Restoration process. Aside from the design of trails at sustainable grades and the inclusion of water bars on those trails *(see above),* the reestablishment of erosion control should be accomplished through placement and husbandry of native vegetation.

North Shore Recreation Area *(see Map 11 in Article 416, Rec. Management Plan)*

In conjunction with rehabilitation and restoration, the North Shore trails will either be eliminated or narrowed and made sustainable by including erosion control and runoff diversion features, primarily in the form of water bars. It has been estimated for purposes of cost projection that 122 water bars would be needed in the North Shore area. In some of the areas most extensively eroded, including part of the width along the main trail descending from the North Shore parking lot to the reservoir, import of fill material will be necessary. In the filled areas, it is not expected that original ground surface will be restored, but rather that sufficient material will be replaced to facilitate the onset of the growth of more or less natural vegetation. This vegetation of native species will then blend with adjacent vegetation and at the same time reestablish erosion control. It will be necessary in many of these areas, especially those where a very broad trail has been narrowed, to place debris in the form of large rocks and slash to prevent pedestrian trespass onto the revegetated width.

A new trailhead linking the North Shore to the Peninsula will be provided at the southeast corner of the parking lot. This trailhead will include signage, a fee station, trash receptacles and a 911 emergency telephone. The 36-inch wide natural surface trail will incorporate existing social trails and new sustainable trail alignments. The exact location of this alignment has been flagged in the field. This trail has been designed not to exceed a 15% grade. Drainage structures will be provided at all necessary locations. All social trails not incorporated in the new alignment will be closed and restored. Drainages damaged as a result of these trails and ensuing erosion will be restored.

Located between these picnic sites, a second trail will connect the North Shore to the Peninsula. This trail will continue on to Rocky Point following existing shoreline fishing trails. The proposed alignment drops down, traversing the deep and badly eroded drainage beneath a prominent rock outcrop. Efforts were made to keep trail grades at less than 15%. In some areas, steps, low walls and other structures will be necessary to hold the slope and maintain sustainable grades. Badly damaged areas within this drainage will be restored. The entire trail alignment has been flagged in the field.

Within the North Shore area, the extent of trail networks that are eroded down to hardrock (see Section 2.3 above) is moderate. Of these areas, about half will require import of growth medium to allow revegetation. The other half (the narrower occurrences) will be addressed by pulling material in from the sides. There is also moderately extensive occurrence of trails eroded down to weathered granite that will be treated as specified in Section 2.2 above. A small amount of trail that has had minor soil loss will be rehabilitated in this area (see provisions of Section 2.1 above).

Peninsula Recreation Area *(see Map 12, in Article 416, Rec. Management Plan)*

For the most part, the existing trail system on the peninsula is stable in its present configuration. There are a few areas where rerouting would make the tread more

sustainable. The addition of a few structures will alleviate some of the minor erosion problems.

Trails to be revegetated in most of this area have minor soil loss and would be treated as set forth in Section 2.1. A small part would require the methods of Section 2.2.

Dam Recreation Area *(see Map 13, in Article 416, Rec. Management Plan)*

All of the facilities will be linked with a 36-inch crusher-fine trail network. This network will connect the sites to several spine trails serving the parking lot and the reservoir shoreline. At select locations throughout this area, restoration and revegetation efforts will be undertaken to soften the impacts of earlier dam construction.

The highly visible talus slope located at the west end of the plateau will be visually softened with large boulders. These boulders will be placed into the aggregate to break-up the uniform and unnatural appearance of the slope. A natural surface trail connecting the overlook to the recreation areas on either side of the plateau will be incorporated into this slope.
Most of the revegetation in this area qualifies for treatment under the provisions of Section 2.2 (i.e. little soil present, exposed decomposed granite as the primary substrate).

South Boulder Creek Outlet *(see Map 14, in Article 416, Rec. Management Plan)*

The new trailhead will provide better access to the creek below the gauging station. This alignment is located lower on the road and will require less elevation gain to get access down to the creek. The trail will be designed at 15% grades and will include several switchbacks. The trailhead will include regulatory signage and a trash receptacle.

Upon abandonment of the old trail alignment, proper trail closure and revegetation should be implemented. Duff and other materials removed during new trail construction should be dispersed along the old trail. In addition, the old tread should be scarified to promote the establishment of new vegetation. Most of the old trail revegetation to be accomplished in this area will be treated using techniques of Section 2.2. A small amount will require movement of material in from the sides (see Section 2.3).

Haul Road Recreation Area *(see Maps 15 & 16, in Article 416, Rec. Management Plan)*

The last 500 linear feet of the end of Haul Road will be narrowed from 35 feet down to 24 feet. This reclaimed road area will provide the setting for these picnic sites.

Log railings and boulders will delineate each site. In addition, a set of log stairs will provide access to the reservoir's shoreline trail.

The steep and badly eroded slopes between the road and reservoir will be regraded and restored with native plant materials.

Runoff from the Haul Road will be diverted into a channelized swale located on the backslope side of the road. Revegetation of the fill outslope will reestablish control of erosion off the face below the parking area.
Of the trails associated with this area that need to be revegetated about half are of the category addressed in Section 2.2. Most of the remainder have had minor soil loss. The single severe soil loss area near one of the inlet along the trail will require some soil import (approximately 0.5 ac) and the remainder (approximately 0.5 ac) will be addressed with provisions of Section 2.2.

South Boulder Creek Inlet

The new 24-inch trail alignment utilizes existing and new trail segments *(see photo 2 page 29)*. All of the new trail segments were designed at 15% grades or less. Some of the existing social trail segments incorporated in the final alignment exceed 15% grades. It was determined that use of these few short existing segments with minimal structural improvements would have less impact than cutting new trail. All existing trail sections not integrated into the new trail will be rehabilitated.

This trail alignment was designed to provide efficient yet sustainable access to the South Boulder Creek Inlet and other secondary fishing destinations along the reservoir. There are several locations where the trail ties into existing sustainable fishing access locations along the reservoir's shoreline. Social trails along the shoreline that are not sustainable will be closed and rehabilitated.

Water bars (approximately one hundred) should be used along the selected / designed trail to control accumulation of runoff waters and dissipate their energy into adjacent areas with high ground cover. Repair of the more extreme examples of erosion damage (such as the steep slope near Drainage 2) will necessitate import of fill (weed-free) to sufficiently alleviate the deep gullies prior to revegetation. It is not anticipated that original grade will be restored in this manner, but rather that the erosional depression will be reduced to the extent that upon revegetation, the slope will blend visually with surrounding areas. The establishment of natural vegetational cover along with accumulation of deadfall on the ground surface will provide the capacity to absorb and diffuse natural precipitation such as existed prior to trail impacts.
Most of these severely eroded areas will be addressed by pulling material in from the sides. Other trail reaches that will be "retired" in this area will be treated with the methods set forth in Section 2.2.

Winiger Gulch Inlet

With the exception of resource protection signage located in the wetlands along the inlet, no other improvements are needed in this area by Denver Water. Revegetation of closed trails would be accomplished using techniques of Section 2.2.

Winiger Ridge Access and Recreation Area *(see Maps 17 & 18, in Article 416, Rec. Management Plan)*

Approximately 4500 feet of existing road devoid of erosion control will be closed and narrowed to trail status. In conjunction with this approximately 127 water bars will be installed to control runoff and erosion along the trails.

The drainage and erosion problems in the parking area will be addressed by the creation of a swale on the south side of the lot. Several feet of fill material will be used to raise the elevation of the parking lot. Below this, an armored (rock) swale will convey water around the parking lot. These improvements will alleviate the ongoing drainage problems at this site. The fill material used to grade the parking area will be comprised of mineral soil and will be weed free.

FDR 359 would be closed to all motorized use about one-half mile west of the reservoir shoreline. All of the existing roads beyond this point will be closed and restored to 24-inch wide natural surface trails that provide access to shoreline campsites. This closure will entail digging up the old roadbed, scarifing the compacted soil and planting native seed mixes.

The existing roads that are converted to trail will be open to non-motorized use throughout the year.

Two small parking lots that accommodate ten vehicles will be provided at this closure. These lots have been located in areas where parking will have the least visual impact. Effective closures, signing and vegetative restoration of temporary roads will be provided to avoid encouragement of off-road recreation use. Fences and boulders will be incorporated at all road closures. Gates will be provided, as needed for emergency vehicle access.

Most of the areas to be revegetated in this area will be addressed by implementation of provisions of Section 2.2. A small amount will require soil import (see Section 2.3).

Jumbo Mountain *(see Map 19, in Article 416, Rec. Management Plan)*

Designated creek access points will be provided and severely eroded banks will be stabilized with boulders.

Rocky Point Area

All of the parking sites and any existing social trail linkages to Jumping Rock will be closed and revegetated. Of this trail network, about one-third will require import of soil material (Section 2.3), while most of the remainder will be treated under provisions of Section 2.2.